A-LEVEL
PHYSICS

7408/3A
Report on the Examination

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General Comments

It is to be hoped that the 12 required practical activities do not become the sole focus of the practical work carried out by A-level students. Many students found some of the descriptive writing challenging, particularly in question 2, exposing a poor grasp of technical vocabulary.

Some students seemed to be unprepared for questions that tested more general ideas about practical work, and offered only generic responses when asked to describe and explain procedures to reduce uncertainty. It is recommended that future students are prepared for examination using the specimen materials, and legacy ISA and EMPA question papers.

Most students were better at applying their theoretical knowledge of the physics and were mostly equal to the parts testing their understanding of the mathematical requirements for A-level.

In this paper, as well as in 7407/2, the truncation of intermediate answers had a detrimental effect on their chances of success in the final stage of a calculation.

Students should aim to work transparently in multi-stage calculations and not assume that examiners will always be able to follow their line of reasoning.

Question 1

This question addressed the ideas behind assessed practical activity 2. Some of the graphical techniques described in the Practical Handbook were also tested. The numerical work in questions 01.4 to 01.6 (and in the multiple-choice part 01.8) was usually where students scored the bulk of their marks.

Questions 01.1 and 01.2 exposed poor understanding of superposition. Although there were plenty of correct answers to 01.1 and very few students forgot to supply any unit (we expected π radians or 180°), there were a variety of unsuccessful alternatives and some students clearly confused path difference with phase difference. Most students seemed to think that the resultant amplitude depended only on the phase difference between the sets of superposing waves, and very few considered the possibility that the waves travelling via M would arrive at R with less amplitude than those travelling directly from T. A small but significant number of students blamed microwave background radiation for the non-zero minimum reading on the ammeter.

Examiners found that many students ‘improvised’ their answer to question 01.3. Developing strategies for encouraging students to think about the practicalities of arranging apparatus, and challenging their reasoning, would pay dividends in future. A simple approach such as measuring, at different points, the distance between M and the line between T and R, and checking these were equal could earn 1 mark; the sensible use of a set-square earned the second mark. Frequent suggestions that non-standard science equipment, such as tri-squares could be used, perhaps indicated that some students had only had limited opportunities to perform practical work. A common misconception was that the ends of rulers can be assumed to be square; several students stated that aligning the end of the ruler, or the graduations along the edge, with the line between T and R, ensured that perpendicular distances would be measured. One really positive aspect of the work seen was the good standard of sketches students used to illustrate their answers; some of these, by themselves, were sufficient to earn both marks.

Answers to question 01.4 were much stronger, with many students demonstrating an understanding of how the error bars could be used to establish the maximum and minimum gradients. Most knew they should use large steps for the gradient calculations, and recognised in question 01.5 that their mean gradient gave λ.

In question 01.6, many students appeared to have taken a guess, often based on the size of the error bars, about the uncertainty they should use. The better students used a variety of valid ways, based around 'best gradient – worst gradient', of judging the uncertainty. However, full credit proved elusive because the final answer was often compromised by the truncation, in 01.4, of the values for maximum and minimum gradients.

Many students seemed to have rushed question 01.7, thinking they were being asked to explain that *y* was the vertical intercept. However, examiners wanted to know how **Figure 4**, which did not allow a direct measurement, should be used. Suggesting a calculation method could earn a mark, but this was denied when any suggested algebra was wrong; otherwise, some consideration of an average of the maximum and minimum intercepts also gained credit.

Question 01.8 provided some respite for students who found the descriptive writing challenging.

Question 2

This question addressed the ideas behind assessed practical activity 9. Students who had seen the second set of specimen questions should have been well prepared for the parts relating to the use of the oscilloscope. It was clear from the descriptive parts of this question, however, that many students had not had direct experience of using an oscilloscope, as shown by the lack of much, if any, use of correct terminology to describe the controls.

Even if some students thought the waveform shown in **Figure 8** showed an ac signal, the instruction to determine the peak to peak voltage should have made question 02.1 straightforward. However, a disappointing number of students found a variety of ways to get this wrong and were similarly unsuccessful with question 02.2.

Those students who obtained 6.3 V and 250 Hz were well-placed to score in question 02.3 and a popular and successful approach was to use $V = V_0 e^{\frac{-\Delta t}{RC}}$; a transparent, viable attempt along these lines could earn a mark, even if the final answer fell outside the required range. Others read off the time interval for *V* to fall to 37% when the capacitor was discharging, but poor communication often made it harder to give any credit, if the final result obtained by this method was unsuccessful. Those using the idea that the capacitor would completely discharge in five time constants were almost invariably unsuccessful due to difficulty in accurately pinpointing the time for 5RC from **Figure 10**.

In question 02.4, most students knew what would happen to the waveform displayed in the oscilloscope when the time-base was adjusted, but often struggled to give a convincing explanation. Stating that the 'waveform would not fit' left examiners looking for further evidence to decide whether the student was referring to vertical or horizontal direction. Some students referred to the 'wavelength increasing', or equivocated by suggested that the waveform 'might not fit'. While better answers suggested that either the charging or discharging parts (but not both) would now be displayed, very few students took a quantitative approach, e.g. that the discharge curve would now be 2.5 times wider. Here and elsewhere in the paper, some students explained that uncertainty would be reduced, but without supporting reasoning this gained no credit.

Question 02.5 discriminated well, with better students stating that the resistance, and hence the time constant, is halved, and spotted the opportunity to give the quantitative detail suggested by the information in the question. The sketches on **Figure 11** showed that some students thought that adding the extra resistor would change the amplitude or the period of the waveform; relatively few students supplied the sketch examiners were looking for.

In the sketch for question 02.6, examiners wanted to see a complete half cycle while the signal generator output was V, and a complete half cycle when the output was zero. Students were generally more successful with the latter, but often failed to consider how **Figures 12a** and **12b** could be used in combination to deduce the other part of the waveform.

In question 02.7, “reduce Y-gain”, or “increase volt per division” could score but an equivocal “change the Y-gain” could not. Once again, extra credit was available for quantitative detail such as “set the gain to 2 V per division”. Some students clearly failed to appreciate that **Figure 12c** showed a graph and was not the way the waveform would appear on the oscilloscope; these students stated that the waveform was already fully visible, so no changes were necessary.

Question 3

Those students who did not fall back on a generic response in question 03.6 gained a significant advantage. The numerical and graphical parts of question 3 were generally done well.

Questions 03.1 and 03.2 were quite accessible for those students who took in all the information from **Figures 13**, **14** and **15**. The data students added to **Table 2** should give the p and x data to a consistent and appropriate number of decimal places. Thus, for $n = 13$ examiners wanted to see $x = 30.0$; a mark was withheld from the many students who missed this point.

In question 03.3, most students earned a mark for working out the ln (x/cm) values correctly, and recording these in a consistent fashion to at least 2 decimal places. The second marking point was much more discriminating, and was forfeited by many students who included the origin, thus compromising the vertical scale. Others did not show the bracket around the axis label correctly, or spaced their values too widely along the axis. The point plotting was generally fine, but some students lost the mark by using ‘blobs’ rather than clearly-defined points, or by drawing a thick or non-ruled line. Those producing a curve could not score here.

In question 03.4, examiners wanted students to point out that their graph was a straight line, and that it had a negative gradient. It was clear that large numbers of students seemed to think that any straight line graph represents direct or inverse proportion. Examiners insisted on seeing ‘linear’ or ‘straight line’, and any mention of proportion (of any sort) was rejected.

Once back to numerical work in question 03.5, students were on surer ground and most measured a gradient before successfully going on to find x when $n = 20$. Students who feel that this type of question is testing maths and not physics should acquaint themselves with section 6 of the specification.

Question 03.6 highlighted once again how ill-equipped some students were when it came to writing with authority about practical procedures to reduce uncertainty. Some immediately seized on the idea that (percentage) uncertainty could be reduced by either increasing the raw measurements, or by reducing the intervals between the markings on a scale. Neither of these things made any sense in the context of the question, so suggestions such as “increase the length of the air track”, and “use a vernier scale”, gained no credit. Some students failed to gain credit here because they suggested the use of lasers or computers to measure distances, or simply gave vague statements about some procedure which ‘will reduce uncertainty’. Students who stuck with what, in the circumstances, would be an obvious and effective strategy, such as repeating and averaging to reduce the impact of random error, were on the safest ground. Whenever data-logging is suggested, examiners expect to see an appropriate sensor identified. In the context of this experiment a motion sensor would be fine, but a light gate would not. The use of video cameras, used increasingly in schools and colleges, to pinpoint p as the glider comes to rest, was accepted either as a means to reduce the impact of random error, or to avoid parallax error.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.